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ABSTRACT

This fourth in a series of eight modules for a course titled Mechanical Inspection describes the classifications of pipe and fittings, the types of connections used in the installation of piping systems, the typical marking schemes, the preinstallation and installation verifications, and the tests of the completed installation. The module follows a typical format that includes the following sections: (1) introduction, (2) module prerequisites, (3) objectives, (4) notes to instructor/student, (5) subject matter, (6) materials needed, (7) procedures, (8) data table, (9) reference materials, (10) test. (The course is one of fifteen technical courses for the second year of a two-year postsecondary curriculum in Nuclear Quality Assurance/Quality Control Technology.) (LRA)

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NUCLEAR TECHNOLOGY

COURSE 30 MECHANICAL INSPECTION

MODULE 30-4 Piping Inspection

CE 024 280

GENERAL PHYSICS CORPORATION
Columbia , Maryland

COURSE MODULES

COURSE 30 MECHANICAL INSPECTION

Module 30-1	Pump Inspection
Module 30-2	Pump Functional Testing
Module 30-3	Valve Inspection
Module 30-4	Piping Inspection
Module 30-5	Surface Cleaning Inspection
Module 30-6	Protective Coating Inspection
Module 30-7	Pressure Vessel Inspection
Module 30-8	Rotating Equipment Inspection

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This module was prepared for General Physics Corporation by Bruce Kinne, General Physics Corporation.

GENERAL PHYSICS CORPORATION

1979

INTRODUCTION

The Nuclear QA/QC Technician assigned to verify installation or modification of piping systems performs a variety of checks to determine compliance with specification, drawings, and procedures. The variety of pipe and fittings requires the ability to recognize specified types including methods of connection. The Technician commences verifications at the time of assembly of materials and completes verifications after the piping system is installed. The specific checks made and the frequency of such checks varies with the importance of the system to safe plant operation.

This module introduces the classifications of pipe and fittings and the types of connections used in the installation of piping systems. Typical marking schemes are described and the basic purposes of fittings are illustrated. Subsequently, this module describes the preinstallation and installation verifications which typically apply to piping systems. Finally, tests of the completed installation are enumerated.

MODULE PREREQUISITES

There are no prerequisites for this module.

OBJECTIVES

Upon completion of this module, the student/trainee can:

1. Name and recognize classifications of pipe and fittings.
2. Match styles of fittings with their function.
3. Recognize pipe and fitting identification schemes and name the types of information identified by typical schemes.
4. Differentiate between permanent and nonpermanent piping connections and describe examples of each type.
5. State the general purpose of piping preinstallation verifications and describe typical verifications.
6. State the general purpose of piping installation verifications and describe typical verifications.
7. Describe the use of records of piping installation and verification including QC Inspection Report, Nonconformance Report, Deficiency Report, and ASME Code Form N-5.
8. State the purpose of flushing and hydrostatic testing and describe principle sources of leakage during hydrostatic testing.

TYPES OF PIPING, FITTINGS, AND CONNECTIONS

Pipe Classifications

The basic definition of pipe is "a tube, usually cylindrical, used for conveying a fluid or transmitting fluid pressure and normally designated as "pipe" in the applicable specification." Piping is classified by two distinct categories: (1) Seam constructed and (2) seamless. Pipe is further classified under these two broad categories by the manufacturing process used to fabricate the pipe.

Seam constructed pipe is fabricated by one of six methods of manufacture. These methods are as follows; Figures 30-4-1 and 30-4-2 illustrate two popular methods:

- Electric Resistance Welded Pipe (longitudinal butt welding with direct current)
- Furnace Butt Welded Pipe Bell Welded (longitudinal butt welding by forging and mechanical pressure)
- Furnace Butt Welded Pipe-Continuous Welded (longitudinal butt welding by forging and mechanical pressure)
- Electric Fusion Welded Pipe (longitudinal butt weld by electric arc welding)
- Electric Flash Welded Pipe (longitudinal butt weld entire length simultaneously via resistance to current)
- Double Submerged Arc Welded Piping (longitudinal butt weld, submerged arc, at least two passes).

Seamless pipe is fabricated by one of five distinct manufactured methods as follows; Figures 30-4-3 and 30-4-4 illustrate two popular methods:

- Rolled Pipe (Forged billet, pierced by a conical mandrel between two diametrically opposed rolls)

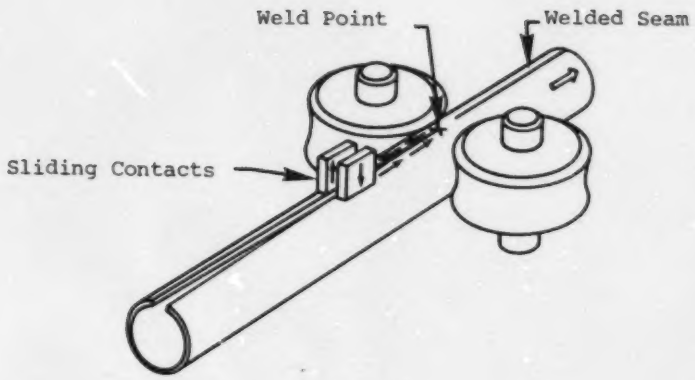


Figure 30-4-1. Electrical Resistance Weld Pipe

- Forged or Bored Piping (Produced by boring or trepanning of a forged billet)
- Extruded Pipe (Produced from hollow or solid round forgings, usually in a hydraulic extrusion press)
- Centrifugally Cast Pipe (formed from the solidification of molten metal in a rotating mold)
- Statically Cast Pipe (Formed by the solidification of molten metal in a sand mold)

Piping Fittings

Forged or wrought fittings are used to connect pipe. Fittings are classified as (1) weld and (2) bolted flange, or (3) compression. They are further classified by shape and purpose. These categories are illustrated in Figures 30-4-5 through 30-4-9.

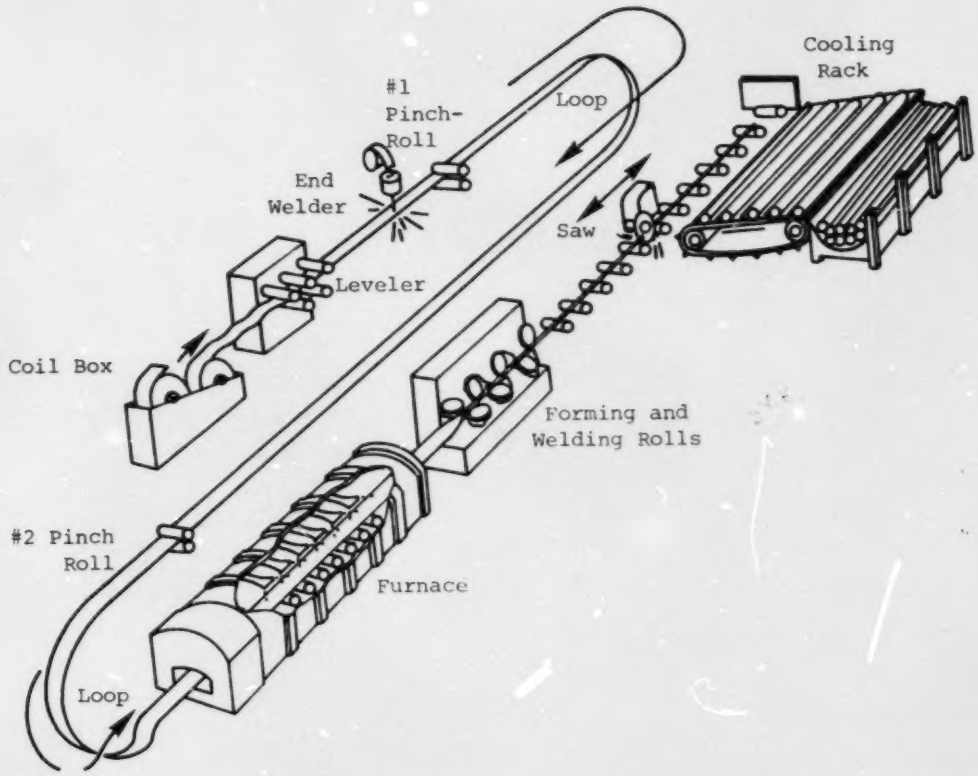
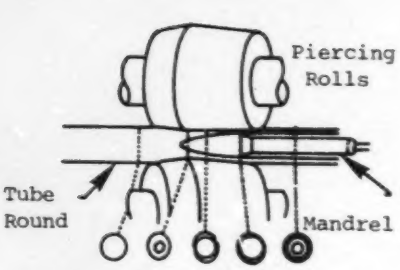


Figure 30-4-2. Furnace Butt Welding Pipe, Continuous Process
(The Yoder Mill Method)



Sections from Solid to Tube

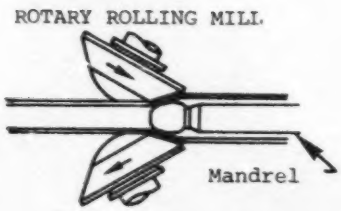
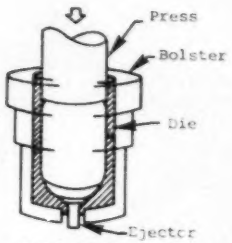


Figure 30-4-3. Rolled Pipe

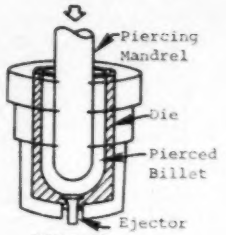
HEATING THE BILLET

A solid steel billet, already worked in rolling from an ingot, is heated to forging temperature.



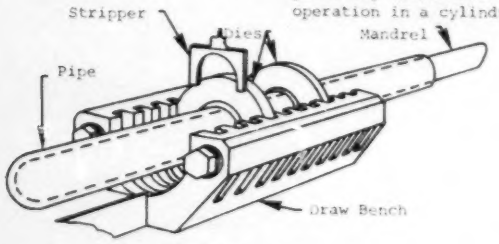
PREFORMING

In this initial forming operation, the heated billet is pressed and partially formed for the piercing operation in a cylindrical "die pot".



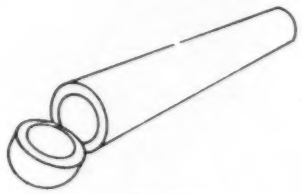
PIERCING

The billet, formed to fit snugly in the die pot, is pressed into a closed-end bellow forging by a piercing mandrel in a vertical press.



HEAT AND DRAW

The forging is pushed through a series of circular dies by a mandrel inserted in the open end. Multiple "draws" are made to reduce the wall thickness and diameter and increase the length.



FINISHING

The closed end may then be retained or removed depending on product application.

Figure 30-4-4. Drawn Pipe

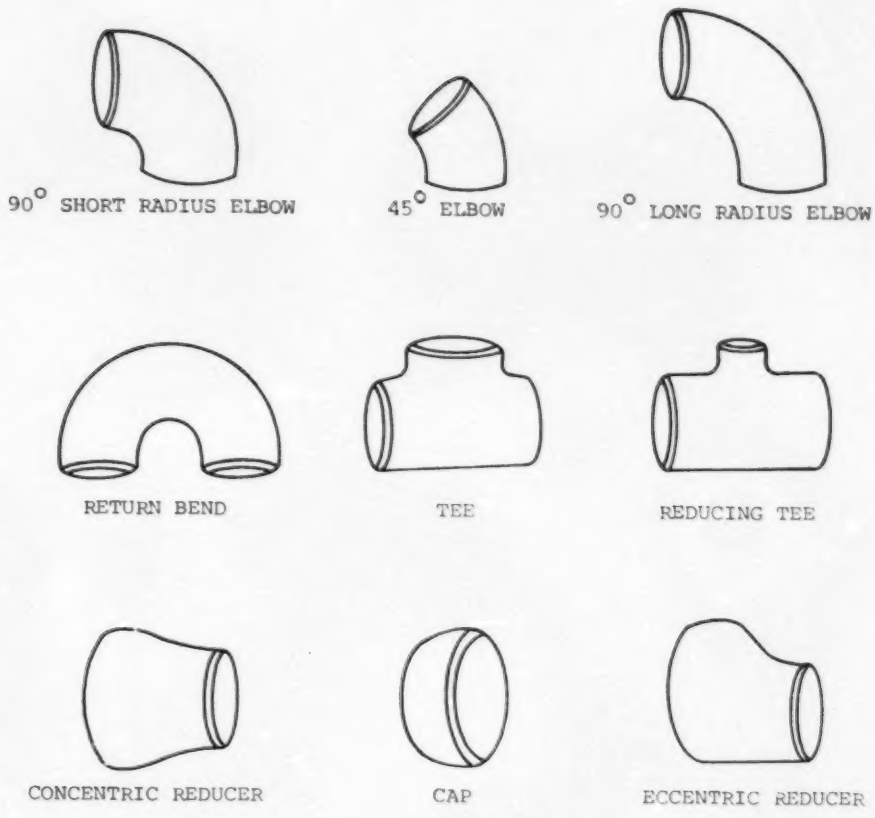


Figure 30-4-5. Weld End Fittings

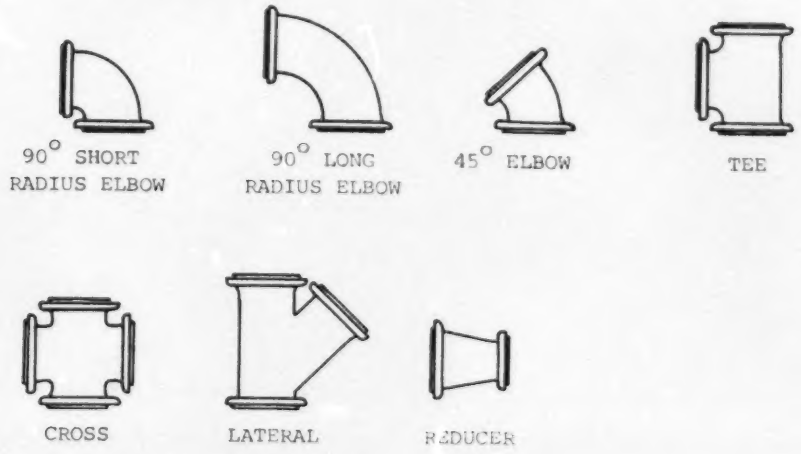


Figure 30-4-6 Cast Bolted Flange Fittings

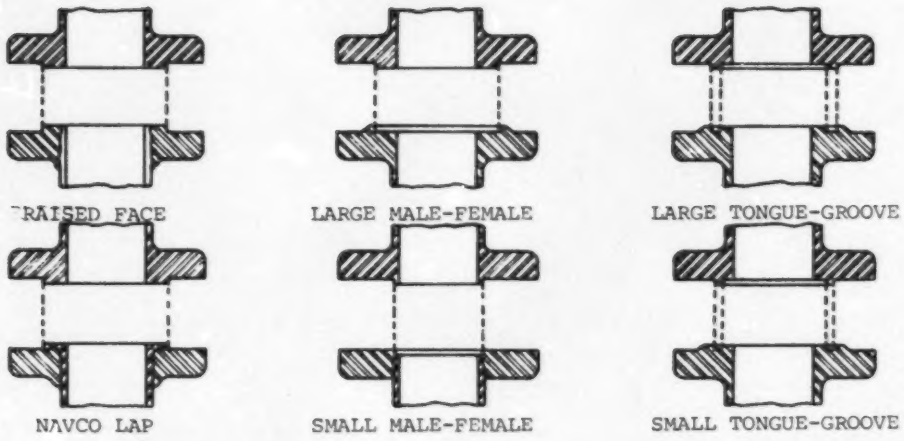


Figure 30-4-7. American Standard Bolted Flange Facings

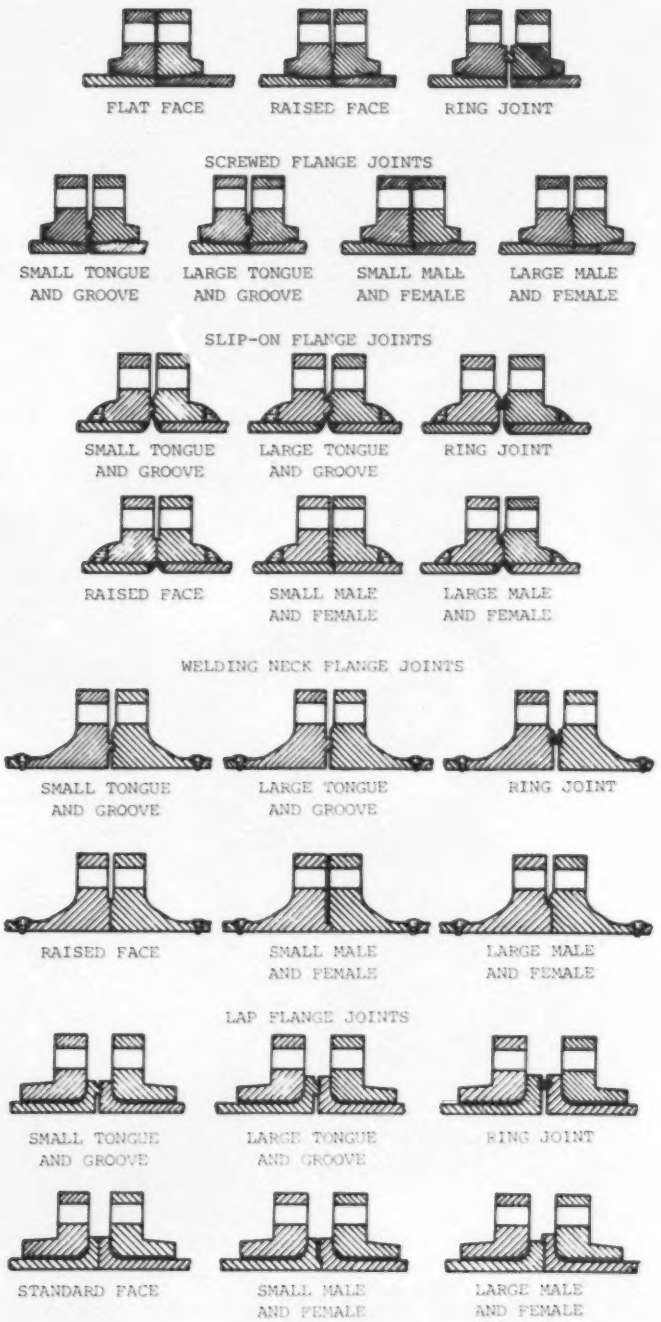


Figure 30-4-8. Bolted Flange Joints

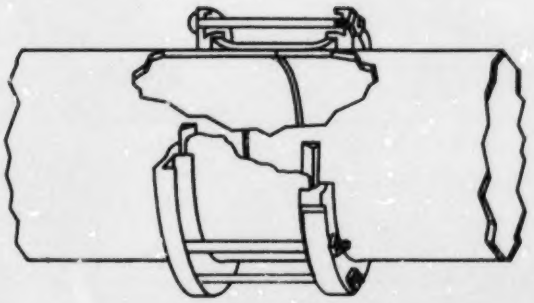


Figure 30-4-9. Compression Sleeve Mechanical Coupling

Identification of Piping and Fittings

Piping and fittings are manufactured in conformance with the various ASME, ASTM or API specifications. Each pipe and fitting is marked by the manufacturer in accordance with the appropriate specification. There are various methods of affixing the markings along with limitiations. The two common practices are diestamping and stenciling. Special requirements apply to both methods to ensure that the marking process does not adversely affect the quality of the pipe. For example, limits are placed on the radius of die stamps to minimize stress concentrations. Stenciling ink must not contain elements which are deleterious to the material. For example, lead is prohibited for stainless steels and inconels. Also, small diameter piping usually found in bundles is marked with a tag attached to the bundle versus individual pipe marking.

Based upon the "Simplified Practices Recommendations R247, Packing, Marking and Loading Methods for Steel Products for Domestic Shipments" which is published by the United States Department of Commerce, and the applicable piping standards, pipe markings generally identify:

- Name or Brand of Manufacture
- Size

- Grade
- Length
- Weight per foot
- Classification of pipe (manufacture process)
- Type of material
- Specification for manufacturing.

Figures 30-4-10 and 30-4-11 illustrate two methods of markings for similar pipe. While similarities exist in these two methods, it is apparent that on-the-job inspection must refer to the specific piping code to determine the exact marking required.

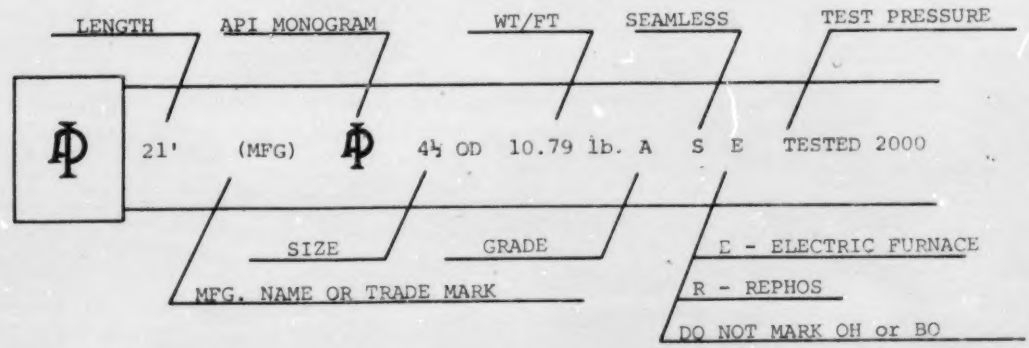


Figure 30-4-10. API Line Pipe 2" and Over

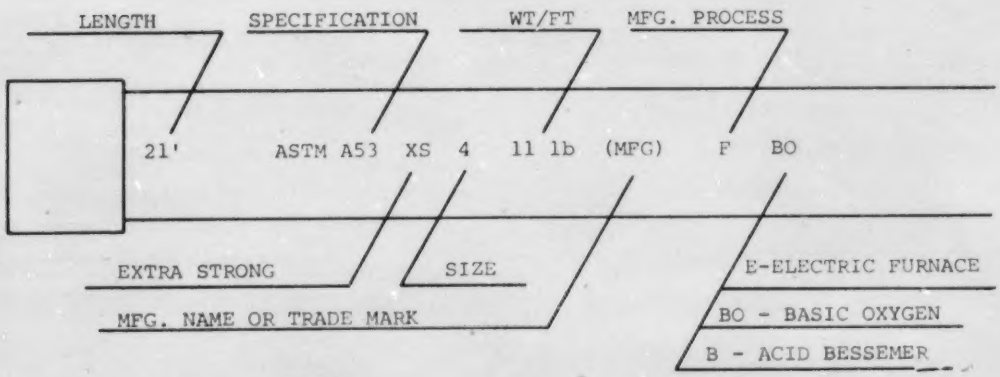


Figure 30-4-11. ASTM A-53 Size 2" and Over

Piping Connections

Piping connections are either permanent of nonpermanent. Permanent connections are those which are welded. Nonpermanent connections are designed for easy disassembly and reassembly. These are comprized of connections by bolted flange, threaded union, and compression sleeve mechanical connection.

Permanent connections are made by a welding process which fuses the two metal pieces. The weld joint used for welded connection is either the butt weld or the socket weld.

As illustrated in Figure 30-4-12, the butt weld joint consists of physically butting the piping ends together. Depending upon the system/piping specification, a backing ring may or may not be used. Where backing rings are not used, a consumable insert may be required for the butt joint. In either case, inspection of butt joints verifies that (1) the ends have been finished per drawing requirements, (2) surfaces are clean and free of paint, oil, rust, scale, or other material, (3) alignment and root openings are accurate within drawing tolerances, (4) alignment is preserved during welding, and (5) the correct weld process is used per the installation specifications.

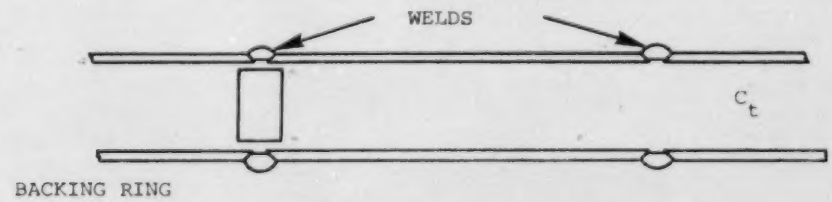


Figure 30-4-12. Butt Welds, With and Without Backing

The first three items for inspection of butt welds apply to inspection of socket welds. In addition, the fit

between the socket and the pipe is verified to comply with the installation specification. Figure 30-4-13 illustrates a typical socket weld which is common in power plants.

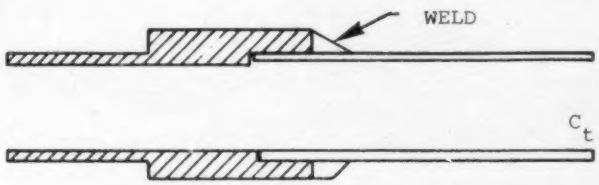


Figure 30-4-13. Socket Weld

Nonpermanent connections vary in complexity and application and their use is dependent upon the design specification for the piping system. The types which usually appear in power plants are:

- Threaded Pipe Joints
- Flanged
- Solder
- Caulked
- Flared/Nonflared Compression Fitting
- Compression Sleeve.

Flanged connections are illustrated by previous Figures 30-4-7 and 30-4-8. Flanged connections exist in many styles, but all require bolting and usually gasket material. The specific design of the flange faces is stipulated by the system piping specification. Gasket material when specified, must be such that it is neither affected by the fluid at operating temperatures nor releases undesired elements into the fluid. Metallic or asbestos-metallic gaskets are used on flat or raised face flanges when fluid operating pressure is high (greater than 720 psi). The bolting for the flange conforms to applicable

American National Standard specifications. Course threads are normally used and washers, nuts and bolts are of the same material.

The Compression Sleeve Coupling illustrated in Figure 30-4-9 relies upon the compression of each of the rubber wedge gaskets to seal each end of the coupling against the pipe and the conically flared middle section. The bolting exerts the required pressure. The resultant joint is flexible and leak-proof.

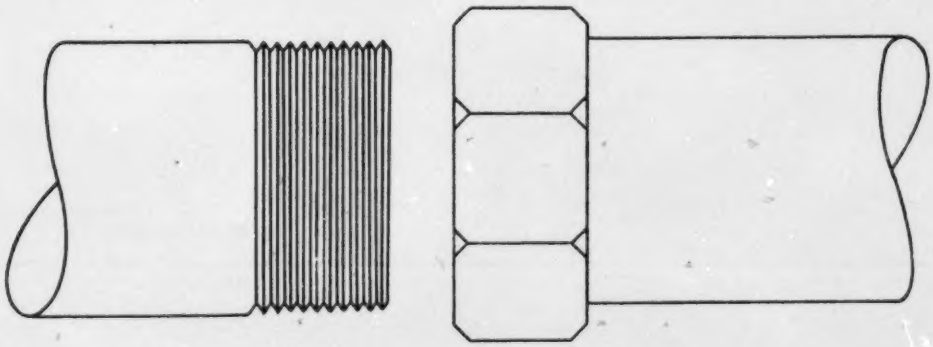


Figure 30-4-14. Threaded Connection

Many threaded pipe joints are tapered threads to provide for tight sealing of the joint. For non-tapered thread connections, a seal weld or a sealing surface other than the threads is used to prevent joint leakage. Limitations on the use of threaded joints include their susceptability to erosion, corrosion, and shock or vibration damage.

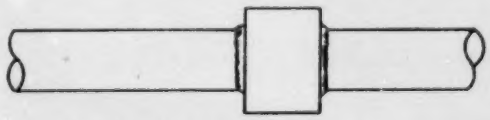


Figure 30-4-15. Soldered Connection

Solder connections are rarely used in power systems but can be found in such systems as low pressure cooling water, potable water, and fire water systems. In almost all cases a socket connection is used with either end-fed brazing material or preinserted rings. Soldered connections which are connected solely by a fillet are unacceptable.

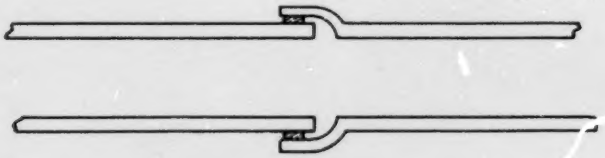


Figure 30-4-16. Caulked Connection

Caulked or lead filled piping connections use the bell and spigot type joint. These are primarily found in cold water service systems. This type of joint or connection has many limitations. If it is intended to be used at pressure, the bends, laterals, and dead ends require lateral support to prevent disengagement.

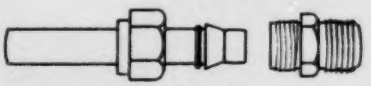


Figure 30-4-17. Flared Fitting

Flared and flareless compression fittings are mostly found in piping runs under 2 inches outside diameter. Instrumentation lines make considerable use of these connections. The compression fitting uses threaded couplers to compress a ferrule or to exert pressure on flared pipe ends by a tapered insert.

INSPECTIONS DURING CONSTRUCTION AND MODIFICATION

Pre-Installation Verification

The pre-installation verification task for a QA/QC Technician begins after a piping run has been scheduled for installation and the materials to be used have been collected by the contractor. It is assumed that receipt inspections were previously completed and personnel assigned to the construction or modification job are "qualified". The role of the QA/QC Technician for this job usually consists of observation and reporting. Of course this will depend upon the character of the QA/QC Department and the particular job requirements.

Preinstallation verifications determine that materials, software, and job conditions are suitable to commence the installation or modification work. Items subject to pre-installation verification are:

- materials are present and of correct type as specified by the job specification and drawings.
- adjacent activities do not adversely effect the job.
- materials are protected from inclement weather.
- specifications, drawings, and instructions are at the job site and approved for use.
- clean areas are established if so required by the job specification.
- installation and inspection check lists, if required, are present and approved for use.

Installation Verification

During installation activities, the Nuclear QA/QC Technician's involvement ranges from "spot checks" to full time verification of installation steps. These verifications may be on a surveillance basis or specific

"hold points" may be established where inspections must be performed prior to work proceeding past such hold points. The complexity of the job and the importance of the piping system to plant safety determines the extent of verifications.

Installation verifications determine that installation processes and the installed piping system comply with applicable specifications, drawings and procedures. Items subject to installation verifications are:

- compliance with procedures such as welding, brazing, and soldering procedures.
- cleanness of components
- protection of components from damage from handling, fixturing, and installing
- accomplishment of inspection hold points, as applicable
- nondestructive examinations of welds and solder joints
- calibration of measuring and test equipment
- completeness of installation including gaskets, bolting, supports and hangers.
- completion of records.

QA Records

Quality assurance programs require the documentation of QA/QC inspections, tests and surveillance. The QC Inspection Report illustrated by Figure 30-4-18 is a typical format for documenting preinstallation and installation verifications.

As illustrated in Figure 30-4-18, the QA Inspection Report is adaptable to any inspection or verification. In the event a nonconformance is identified, a separate report similar to that in Figure 30-4-19 is issued. Use of a separate report for nonconformances permits convenient review and disposition by responsible departments.

QUALITY CONTROL INSPECTION REPORT 1.0 QCTR. NO:_____

2.0 SITE LOCATION: _____ 6.0 WR OR MOD NO: _____

3.0 SYSTEM NAME/NO. _____ 7.0 CLASS I II III

3.1 COMPONENT NAME/NO. _____ 8.0 MATERIAL REPLACEMENT REQUIRED_____

4.0 RESPONSIBLE DEPT/GROUP _____ 8.1 MATERIAL CERTIFICATION REQUIRED _____

5.0 ACTIVITY LOCATION _____ 8.2 MATERIAL PURCHASE ORDER NO. _____

9.0 PROCEDURE TITLE/NO. _____

10.0 PREREQUISITES ACCOMPLISHED YES ____ NO____ (IF NO, EXPLAIN UNDER REMARKS)

11.0 REASONS FOR ACTIVITY:

12.0 WORK DESCRIPTION (INCLUDE MATERIAL AND COMPONENTS USED):

13.0 RETEST REQUIREMENTS:

14.0 TESTS PERFORMED:

15.0 TEST DATA:

16.0 REMARKS:

17.0 QC INSPECTOR _____ DATE/TIME _____

Figure 30-4-18. Sample Inspection Report

Nonconformances denote a material or component condition which violates specification or drawing requirements. In addition to nonconformances, other problems may be identified such as violations of procedural requirements. Such violations are typically termed "deficiency" or "noncompliance" and are separately reported. A sample deficiency report form is illustrated in Figure 30-4-20. The form permits addition of corrective action by the responsible contractor to rectify the deficiency and to prevent its reoccurrence.

Many of the piping systems of a nuclear power plant are subject to the provisions of the ASME Boiler and Pressure Vessel Code (Code). In such cases, the Code requires the

completion of a "Data Report for Field Installation of Nuclear Power Plant Components, Component Supports, and Appurtenances." This report is numbered "N-5" and is illustrated in Figure 30-4-21.

The N-5 form provides for recording the specific items which are installed to comprize a system and for certifying compliance of such items with the Code. It includes pumps, valves, and piping assemblies and it lists the specifications, drawings and procedures complied with by the installation process. The QA/QC verifications of preinstallation and installation activities serve as a basis for the owner's acceptance of the N-5 report.

QUALITY CONTROL NONCONFORMANCE REPORT (NCR)

Site Location: _____ Report No. _____

Date _____

Component Identification _____ System # _____

Purchase Order # _____ Specification # _____

Supplier/Contractor _____ Dwg. # _____

Inspected by _____ Hold/Reject

Approved by _____ Tag # _____

QC Supervisor

Item Description of Nonconforming Material

Recommended Action:

Accept As Is ___ Scrap ___ Rework ___ Return ___

Corrective Action/

Preventative Action: _____

_____

_____

_____

By: _____ _____

Date

Response Accepted By: _____ _____

Date

Reowrk Complete	Rework Inspected	Nonconformity Closed
	Accepted _____	
	Unaccepted ____	_____
By _____	By _____	QC Supervisor
Date _____	Date _____	Date _____

Figure 30-4-19. Sample Nonconformance Report

DEFICIENCY AND CORRECTIVE ACTION REPORT

Report No._____

Need for Corrective Action: Date _____

Failure _____

Malfunction _____ APPROVED BY: _____
QC SUPERVISOR

Deficiency _____

Deviation _____ HOLD/REJECT

Defective Equipment _____ TAG # _____

Component Identification _____ System No. _____

Purchase Order No. _____ Spec. No. _____

Supplier/Contractor _____ Drawing No. _____

Corrective Action Requested of _____

Description of Condition:

Cause of Condition:

CORRECTIVE ACTION/
PREVENTIVE ACTION:

By: _____ _____
Date

Response Accepted By: _____ _____
QC Supervisor Date

Implementation

Verfied By:

Figure 30-4-20. Sample Deficiency Report

FORM N-5 DATA REPORT FOR FIELD INSTALLATION OF NUCLEAR POWER PLANT COMPONENTS, COMPONENT SUPPORTS, AND APPURTENANCES*
As Required by the Provisions of the ASME Code Rules, Section III, Division 1

1. Installed by _____ (Name and address of installer of component, component supports or appurtenances)
2. Installed for _____ (Name and address of purchaser or owner)
3. Location of Installation _____
4. System Identification _____ (Mfgr's Serial No.) (CRN) (Drawing No.) Nat'l Bd. No. _____ Year Installed _____
5. Nuclear Components and Appurtenances Installed in the Field by Welding (List each item and attach copies of N Certificate Holders' Data Reports and NPT Certificate Holders' Partial Data Reports)

(a) Components, or Appurtenances	(b) Name of Certificate Holder	(c) Serial No.	(d) Canadian Reg. No.	(e) National Bd. No.	(f) Year Built

Piping System Installation

(a) Piping Subassembly	(b) Name of Certificate Holder	(c) Serial No.	(d) Canadian Reg. No.	(e) National Bd. No.	(f) Year Built

Component Support Installation

(a) Component Support No.	(b) Name of Certificate Holder	(c) Serial No.	(d) Stress Rept. Load Capac. Data Sheet	(e) Canadian Reg. No.	(f) National Bd. No.	(g) Year Built

Additional Material Excluding Welding Material

(a) Name of Manufacturer	(b) Material Specification	(c) Dimensions

* Supplemental sheets in form of lists, sketches, or drawings may be used provided (1) size is 8-1/2 in. × 11 in., (2) information in items 1 through 3 on this Data Report is included on each sheet, and (3) each sheet is numbered and the number of sheets is recorded at the top of this form.

This form may be obtained from the Order Dept., ASME, 345 E. 47 St., New York, N.Y. 10017

SAMPLE

Figure 30-4-21A. ASME N-5 Form

FORM N-5 (Back)

6 (a) Installation in Accordance with:
Procedure or Drawing No. _____ Prepared by _____

(b) Description of Installation Performed: _____

(c) Hydrostatic Test _____ psi. System Working Pressure _____ psi and Temp _____ F

CERTIFICATION OF DESIGN FOR PIPING SYSTEM INSTALLATION

Design information on file at _____
Stress analysis report on file at _____
Design specifications certified by (1) _____ PE State _____
Reg. No. _____
Stress analysis report certified by (1) _____ PE State _____
Reg. No. _____
(1) Signature not required. List name only.
Design Conditions of Piping _____ (Pressure) psi _____ (Temperature) F

CERTIFICATE OF COMPLIANCE

We certify that the statements made in this report [illegible] and that this installation conforms to the rules of construction of the ASME Code for Nuclear Power Plant Components, Section III, Division 1 _____ Edition Addenda _____ (Date). Code Case No. _____ Class _____ and was performed in accordance with the documents listed in 6(a), above.
Date _____ Signed _____ by _____
Our ASME Certificate of Authorization No. _____ to use the _____ (N, NA) Symbol expires _____ (Date)

CERTIFICATE OF INSPECTION

I, the undersigned holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and the State or Province of _____ and employed by _____ of _____ have inspected the piping described in this Data Report on _____ 19____ and state that to the best of my knowledge and belief, the Certificate of Authorization Holder has constructed this installation in accordance with the ASME Code for Nuclear Power Plant Components.

By signing this certificate, neither the Inspector nor his employer make any warranty, express or implied, concerning the piping described in this Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ 19____.
Signed _____ (Inspector) Commissions _____ (Nat'l Board, State, Province and No.)

Following completion of the above, the Certificate of Authorization holder accepting overall responsibility for the system shall complete the following statement.

We certify the statements made by this report are correct and that the system conforms to the rules of construction of the ASME Code Section III, Division 1.
Date _____ Signed _____ (N Certificate Holder) By _____
Certificate of Authorization Expires _____
Certificate of Authorization No. _____

SAMPLE

Figure 30-4-21B. ASME N-5 Form

Functional Inspections and Tests

Upon completion of the installation or modification and prior to the release of the system for operation, preoperational and functional testing is usually required. This testing includes, but is not necessarily limited to:

- leak tests
- flushing
- hydrostatic test
- valve tests
- pump tests
- system functional tests

The pipe per se is accepted based on the results of flushing and hydrostatic testing. The system is flushed with demineralized water to ensure it is clean and free of any undesirable chemical which could ultimately lead to corrosion. System flushing cleans inside surfaces to the specified level of cleanliness. Hydrostatic tests are typically performed at a test pressure of 125% of design and "prove" the integrity of the pressure boundaries of the system. Generally system pumps in the plant are available for this purpose. For example, the hydrostatic test for the Reactor Coolant System (RCS) for a Pressurized Water Reactor (PWR) system employs charging pumps from the Chemical and Volume Control System (CVCS), which processes the RCS water, during normal operation, but has sufficient pump head to supply the 125% of design pressure required for the hydrostatic test. During the hydrostatic test, a careful examination of the entire system is performed. Pipe-to-pipe, pipe-to-fitting, and pipe-to-component connections are most probable sources of leakage during hydrostatic testing.

In addition to flushing and hydrostatic testing, some systems are leak tested. These are systems which require very low leak rates such as refrigeration systems.

EXERCISES

The following exercises serve to reinforce the material presented in this module.

1. Following procedure #1 which is presented in the Procedures section of this module perform an inspection of piping and fitting specimen samples outlined in the procedure. Using the information presented in this module identify each specimen. Collect your data on Table 30-4-1 in the Data Table section of this module.

2. Visit a plant which contains one or more mechanical piping systems where a new system is being installed or where existing system modifications are being made. Plants of this type could include:
   - The steam heating plant at your school.
   - A manufacturing plant in your town.
   - An electrical power station in your area.
   - A water treatment plant for your town.

   a. Visit one of the above facilities during installation or system modification activities.
   b. The QA/QC technician's involvement ranges from "spot checks" to full-time verification of the installation steps. These verifications may be on a surveillance basis or specific "hold points" may be established where inspections must be performed prior to work proceeding past such hold points. The complexity of the job and the importance of the piping system to plant safety determines the extent of verifications.
   c. Using the Procedure #2 given in the Procedures section of this module along with the assistance of the QA/QC inspector at the plant site, determine if the installation processes and the installed piping system comply with the applicable specifications, drawings and procedures.

d. Use Table 30-4-2 in the Data Table section of this module to assist you during this inspection.

3. Discuss the pipe and fitting identification schemes and name the types of information identified by typical schemes.

4. Explain the difference between permanent and nonpermanent piping connections.

5. Explain the general purpose of piping preinstallation verifications and describe typical verifications.

6. Discuss why piping installation verifications are necessary and describe typical verfications.

7. Briefly describe the use of records of piping installation and verification including:
   a. QC inspection report
   b. Nonconformance report
   c. Deficiency report
   d. Code Form N-5

8. Briefly explain the purpose(s) of flushing and hydrostatic testing and describe the principle sources of leakage during hydrostatic testing.

9. Answer the following questions as either true of false:
   ____ a. Permanent connections are made by welding using butt or socket joints.
   ____ b. Nonpermanent connections are made by bolted flange, thread union, compression sleeve, flared or flareless compression fittings, soldered joints, or caulked joints.

____ c. Preinstallation verifications determine that materials, software, and site conditions are suitable for commencement of installation.

____ d. Installation verifications determine that installation processes and the completed installation comply with applicable specifications, drawings, and procedures.

____ e. Preinstallation verifications check such items as (1) materials, (2) adjacent activities, (3) protection from environment, (4) software, (5) cleanliness controls, and (6) installation and inspection check lists.

____ f. Installation verifications check such items as (1) procedural compliance, (2) component protection, (3) inspections, (4) nondestructive examinations, (5) cleanliness, (6) measuring and test equipment, (7) completed installation, and (8) records.

____ g. QA records associated with piping installations include (1) QC Inspection Report, (2) Nonconformance Report, (3) Deficiency Report, and (4) Code Form N-5.

____ h. Post installation or preoperational tests of piping include flushing, leak testing, and hydrostatic testing. Installed piping systems are accepted based primarily on the results of flushing and hydrostatic testing.

MATERIALS

The following Materials are required to support this module:

1. Pipe sample, seamless with identification ID marks.
2. Pipe sample, with seam with identification ID marks.
3. Flange Faces
4. Socket Joints
5. Flare Fittings

PROCEDURES

The following Procedures support Exercises #1 and #2 of this module.

Procedure #1: Piping and Fitting Specimen Identification (Refer to Exercise #1)

a. Using unidentified specimens of pipe and fittings, identify both according to the following classification:

(1) Pipe:

- Pipe is classified as seam constructed and seamless and by method of manufacture of each class.
- Seam constructed pipe is fabricated by one of six methods: (1) electric resistance welded pipe, (2) furnace butt welded pipe-bell method, (3) furnace butt welded pipe continuous method, (4) electric fusion welded pipe, (5) electric flash welded pipe, and (6) double submerged arc welded pipe.

- Seamless pipe is fabricated by one of five methods (1) rolled pipe, (2) forced or bored pipe, (3) extruded pipe, (4) centrifugally cast pipe, and (5) statically cast pipe.

(2) Fittings:
- Fittings are classified as welded end, bolted flanges, or compression.
- Elbows accomodate turns in piping runs.
- Tees join three piping runs at right angles
- Reducers connect two different sizes of pipe.
- Cross connections connect four piping runs at right angles.
- Laterals permit the branching of one piping run into two runs or vice versa.

(3) Piping and Fittings:
- Piping and fitting identification schemes provide for the identification of (1) name or brand of manufacturer, (2) size, (3) grade, (4) length, (5) weight per foot, (6) classification, (7) type of materials, and (8) specification for manufacturing.

(4) Identify each unknown specimen and list each in Table 30-4-1 provided in the Data Table section of this module.

Procedure #2: Installation Verification of Installation Processes and Installed Piping Systems. (Refer to Exercise #2)

a. Visit a plant in which a mechanical piping system is being installed.

b. With the assistance of the QA/QC inspector on site, determine if the installation processes and the installed piping system comply with the applicable specifications, drawings and procedures.

c. Installation verifications determine that installation processes and the installed piping system comply with applicable specifications, drawings and procedures. Items subject to installation verifications are:
   (1) Compliance with procedures such as welding, brazing, and soldering procedures.
   (2) Cleanness of components.
   (3) Protection of components from damage from handling, fixturing, and installing.
   (4) Accomplishment of inspection hold points, as applicable.
   (5) Nondestructive examinations of welds and solder joins.
   (6) Calibration of measuring and test equipment completeness of installation including gaskets, bolting, and supports and hangers.
   (7) Completion of records.

d. To assist you in the installation verification, complete Table 30-4-2 in the Data Table section of this module.

DATA TABLE

Table 30-4-1

Piping and Fitting Identification

Specimen Number	Type of Piping or Fitting	Typical Use

Table 30-4-2

Sample Inspection Report

QUALITY CONTROL INSPECTION REPORT 1.0 QCTR. NO:_____

2.0 SITE LOCATION: _____ 6.0 WR OR MOD NO: _____

3.0 SYSTEM NAME/NO. _____ 7.0 CLASS I II III

3.1 COMPONENT NAME/NO. _____ 8.0 MATERIAL REPLACEMENT REQUIRED_____

4.0 RESPONSIBLE DEPT/GROUP _____ 8.1 MATERIAL CERTIFICATION REQUIRED _____

5.0 ACTIVITY LOCATION _____ 8.2 MATERIAL PURCHASE ORDER NO. _____

9.0 PROCEDURE TITLE/NO. _____

10.0 PREREQUISITES ACCOMPLISHED YES ____ NO____ (IF NO, EXPLAIN UNDER REMARKS)

11.0 REASONS FOR ACTIVITY:

12.0 WORK DESCRIPTION (INCLUDE MATERIAL AND COMPONENTS USED):

13.0 RETEST REQUIREMENTS:

14.0 TESTS PERFORMED:

15.0 TEST DATA:

16.0 REMARKS:

17.0 QC INSPECTOR _____ DATE/TIME _____

REFERENCE MATERIALS

ASME, Boiler and Pressure Vessel Code, Section III, The American Society of Mechanical Engineers, 1978

ASM, Metals Handbook Vol. 6, The American Society for Metals, 1971

LEC, The Procedure Handbook of ARC Welding, The Lincoln Electric Company, 1973

ASME, Requirements for Collection, Storage and Maintenance of Quality Assurance Records for Nuclear Power Plants, ANSI N45.2.9, The American Society of Mechanical Engineers, 1974

ASME, Supplementary Quality Assurance Requirements for Installation, Inspection and Testing of Mechanical Equipment and Systems for the Construction Phase of Nuclear Power Plants, ANSI N45.2.8, The American Society of Mechanical Engineers, 1975

ASME, Power Piping, ANSI B31.1, The American Society of Mechanical Engineers, 1973

AISI, Carbon Steel Pipe, Structural Tubing, Line Pipe, Oil Country Tubular Goods, American Iron and Steel Institute, 1973

AISI, Stainless and Heat Resisting Steels, American Iron and Steel Institute, 1974

TEST

1. Name two basic classifications of pipe.

2. Name three manufacturing methods for seam constructed pipe.
   a.
   b.
   c.
3. Name three manufacturing methods for seamless pipe.
   a.
   b.
   c.
4. Name the fitting which serves the function described:
   a. Connects three piping runs at right angles

   b. Connects larger pipe to smaller pipe on same centerline.

   c. Connects two piping runs at a right angle.

   d. Accomodates a small bend in a piping run.

   e. Accommodates a 180° turn in a piping run.

5. Name three basic classifications of fittings.
   a.
   b.
   c.
6. Name seven items of information typically included in pipe and fitting identification schemes.

7. Differentiate between permanent and nonpermanent piping connections.

8. Name two types of joints used to connect pipe and fittings by welding.
   a.
   b.
9. Name six types of nonpermanent joints used to connect pipe and fittings.

10. State the purpose of piping preinstallation verifications.

11. Name six items subject to piping preinstallation verification.

12. State the purpose of piping installation verifications.

13. Name eight items subject to piping installation verification.

14. State the purpose of each report:
   a. QC inspection report

b. Nonconformance report

c. Deficiency report

d. Code Form N-5

15. How are inside surfaces of pipe cleaned after completion of installation?

16. What test serves to "accept" the installed piping system?

17. What are the most probable sources of leakage in piping runs?